Influence of Macroeconomic Variable on Indian Stock Movement: Cointegration Approach

Harsh Vardhan and Pankaj Sinha

International Management Institute (IMI), Delhi, Faculty of Management Studies, University of Delhi

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Abstract

The purpose of this study is to explore the influence of identified macroeconomic variables on Indian stock returns during the post liberalization period using Vector Error Correction Model (VECM). It was found that the nine macroeconomic variables have both long-term relationship and short-term relationship with SENSEX returns. This fact provided insight into a variety of interesting interrelationships between multiple macroeconomic variables, which gives direction for further reforms in the emerging market.

Keywords: Cointegration, Vector Error Correction Model, Macroeconomic Variables

JEL Classification: C58, C54, G23, G18, G15

[1] Dr. Harsh Vardhan, International Management Institute (IMI), Delhi

[2] Dr.Pankaj Sinha, Faculty of Management Studies (FMS), University of Delhi, Delhi

1. Introduction

In a globally integrated world, policies and economic initiatives influence not only the domestic economy but also equity returns. Liberalization and globalization are the twin forces that have transformed the Indian economy over the last two decades. Changes were rapid, visible and touched all sectors of our economy. The changes in Indian capital markets have facilitated easier access to funds by Indian industry. The growth of the economy depends upon multiple elements, such as fundamental macroeconomic factors, investment climate, the performance of industry sectors and global business environment. An understanding of factors that influence the movement of stock prices affecting economic growth is essential for both investors as well as policy makers.

The research paper studies the influence of post-liberalization measures impacting macroeconomic variables as well as Indian stock returns. It identifies suitable robust VECM, based on identified macroeconomic variables influencing the stock prices and explaining their relationships. The study examines long-run and short-run relationships between these macroeconomic indicators and the Sensex. The findings may give an insight and direction for policy reforms.

This study investigates both short-run and long-run relationships between the nine identified macroeconomic variables and Indian stock returns in the post-liberalization period for monthly data from 1995 to 2009. The specific questions investigated are: Do the identified variables share long-run equilibrium, short-run and causality relationships? What is the relative importance of each variable in bringing about fluctuations in others? What are the policy implications? In order to answer the above questions, first stationarity of the time series is examined. Then robust VECM is estimated. The proposed model estimates relationships between Sensex, SP500, WPI, IIP, Exchange Rate (EXR), Money Supply (M3), Import (IMPO), Export (EXPO), Foreign Exchange Reserve (FER), and Gold Price (GP).

The review of the literature between the fundamental economic activities and stock market price indicated that there are divergent views amongst the researchers about the relationships between stock market returns and the underlying macroeconomic variables. This difference was due to the uniqueness of economic conditions of countries and their responsiveness to global integration.

Several studies have been conducted on the relationships between macroeconomic variables and stock returns for developed economies, but a few for Indian stock returns. It suggests a need for a study in which macroeconomic variables are selected on the basis of their current economic relevance.

This study employs robust VAR methodology for multivariate framework developed by **Sims (1980). Sims** shared Nobel Prize in 2011 along with **Sergant**, for his seminal contribution to developing VAR models as an empirical tool for linking macroeconomic study with policy analysis. This study uses **Johansen and Juselius (1990)** method of determining cointegration to identify suitable VECM.

VECM shows that the identified nine macroeconomic variables influence Sensex returns and have short-run, long-run and causality relationships. Sensex is not the leading indicator; the three cointegrating vectors jointly bring back the system to the long-run equilibrium. The increase in IIP was expected to be positively related to stock price, but the relationship was found to be negative. It may be because IIP (base year 1993-94) had outdated weights and dormant companies. The hypothesized pair-wise positive relationships between Sensex returns and exchange rate, imports, foreign exchange reserves and gold price were found to be true. The findings also confirm the hypothesized negative relationship between Sensex returns and money supply and WPI. For strengthening the Indian stock market, investment climate needs to be improved by ensuring reliability in tax laws and by curbing inflation. Policies conducive for investments and the stable exchange rate would maintain the inflow of FIIs while speeding up reforms are essential for growth and value creation.

2. Literature Review

The literature review has been conducted on the major research done on the subject for both developed and Indian market. It has come out with conflicting relationships between macroeconomic variables and stock market index due to unique dynamic economic conditions. The research question of the study is whether the macroeconomic variables significantly explain stock market return and the hypothesized relationship between the variables.

Few studies have been conducted by examining the relationship between macroeconomic variables with Indian stock market returns that are described in the next paragraphs:

Tripathi N (2011) examined the relationship between the stock market return and number of macroeconomic variables, using weekly observations on Sensex, WPI, Treasury bill rates, Exchange rate, S&P 500 and BSE trading volume. It was also found that the Indian stock market is sensitive to changing behavior of the international market, exchange rate, and interest rate .The stock market is not weak form efficient. It implied that abnormal returns can be attained by using historical data on stock prices and macroeconomic indicators.

Singh D (2010) has explored the causal relationship between macroeconomic variables and stock market for monthly data from April 1995 to March 2009. The selected variables are BSE, WPI, IIP, and exchange rate. Granger causality test indicated that IIP is the only variable having bilateral causal relationship with Sensex, whereas, WPI and Sensex have unilateral causality.

Agarwal & Tuteja (2008) studied the causal relationship between industrial production and share price index for India by using vector correction model, which include macroeconomic variables: money supply, credit to private sector, exchange rate, WPI and money market rate. The focus of the study investigated relationship between the health of economy and health of the stock market. It was found that the share price index and macroeconomic variables were cointegrated. Further the Indian stock markets are demand driven and industry led.This implies that higher industrial production results in higher demand for equity finance, but increasing price of stock markets does not indicate revival of the Indian economy.

Pradhan PC (2007) examined the causal linkages between the stock market and economic activity in India. Toda-Yamamota, Dolado and Lutkephol (TYDL model has been used for testing Granger non-causality . The cointegration test indicates existence of one cointegrating vector. Bi-directional causality between stock price and economic activity during the post-liberalization period was found .It indicates that a well-developed stock market could improve economic activity and vice-versa. The main limitation of the paper is usage of IIP as a proxy for economic activity, which neglects two primary sectors - agricultural and service sector.

The review of the literature on the relationship between the fundamental economic activities and stock market price indicated that there are divergent views amongst the researchers about their relationships. Some were able to establish relationships, but some could not determine any. As observed, there have been limited numbers of studies conducted for the Indian stock market till now. Thus, the review of the existing research work suggests that there is a need for conducting another rational study, to understand long-run and short-run relationship and determine the direction of causality between the identified macroeconomic variables and emerging Indian stock market. The significance of their relationships will help in the suitable policy formulation.

3. Data ,Variables & Methodology

The sample consists of 180 monthly observations for each variable from January 1995 to December 2009. The data has been collected from the four databases of the Centre for Monitoring Economy (CMIE) - namely Prowess, Economic Intelligence Service (EIS), Business Beacon, Industry Analysis Service (IAS); and the other data sources are the Hand Book of Statistics on Indian Economy, RBI, Director General of Commercial Intelligence and Statistics (DGCI& S), bloomberg and www.lbma.org.uk.

We have selected macroeconomic variables based on the literature review starting from the path breaking contribution of **Chen, Roll and Ross (1986)** till the studies done by **Rad A(2011); Asaolu T & Ogunuyiwa(2011); Hosseini M, Ahmad Z & Lai Y (2011)** for determining a basic econometric model.

The Error Correction Model (ECM) will be the most suitable in comparison to a model comprising of the first difference of the macroeconomic variables. The ECM will capture both long- and short-term relationship between the time series.

The three viable models are:

Model 2: Trend assumption: No deterministic trend (restricted constant)

Model 3: Trend assumption: Linear deterministic trend

Model 4: Trend assumption: Linear deterministic trend (restricted)

Johansen Cointegration Test

Johansen two test statistics for cointegration are:

$\lambda(r)_{trace}$= -T $\sum_{i=r+1}^{g} l_n(1-\hat{\lambda}_i)$ ……1

and

$\lambda(r, r+1)_{max}$= -T log $(1-\hat{\lambda}_{r+1})$……2

Where r is the number of cointegrating vectors under the null hypothesis.

The methodology employed in determining robust Vector Error Correction Model (VECM) has been discussed in the study of **Vardhan, Vij & Sinha (2013), Vardhan, Sinha and Vij, (2015).**

The Vector Error Correction Model (VECM) for $Y_t = A_1 Y_{t-1} + C_1 + u_t$, with one lag is given by

$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Pi Y_{t-1} + C + u_t$,

Where, Y_t is a matrix of endogenous variables, $\Gamma_1 \Delta Y_{t-1}$ indicates short run relationship

ΠY_{t-1} indicates long term relationship or error correction

The matrix Π contains information relating to long-run relationship between the endogenous variable.

Rank of Π indicates number of cointegrating relationships between y's

$\Pi g \times g = \alpha\beta'$, where $\alpha_{g \times r}$ and $\beta'_{r \times g}$

Where number of variables is g, rank or number of cointegrating vectors is r, k is the number of lag.

α is the speed of adjustment to equilibrium coefficient,

β' is the matrix of parameters indicating the cointegrating vectors,

$\beta' y_{t-1}$ = error correction term or long run equilibrium error.

The adjustment factors α_{ij} associated with Co integrating Equations (CEs) measure the expected speed with which the model returns to the long term equilibrium position following an exogenous shock. α_{ij} i=1,2…,10 & j=1,2,3 (i= no. variables & j= no. of cointegrating equations)

It is seen that there are three CEs for a VAR model comprising of 10 variables (thus g=10, k=1 & r=3, α is g*r=10*3, β'=r*g=3*10 and Π_{10*10}).

4. Data Analysis & Empirical Findings

All variables are transformed into natural logarithm, and their first difference is taken. **Table 1** gives transformation of variables and their significance.

Table1: Time Series Transformation

The descriptive statistics of log-transformed variables indicates that the standard deviation for log imports(LIMP) is highest (0.8143) indicating high volatility measured by the high coefficient variation of 6.49%.Whereas, the lowest coefficient of variation is 3.2% for the exchange rate (EXR) showing its least variability. The JB statistics indicates non-normality at α =5% for most of the distributions, as their p-values are less than 0.05. Most of the distributions are positively skewed except for LEXR (-0.991), LSP 500(-0.951), and LM3 (-0.191). The distributions of LSP500 and LEXR have kurtosis 3.233 and 3.048, respectively, which implies that both are almost normally distributed whereas distributions of remaining transformed variables are platykurtic. The bivariate correlation coefficients between the pairs of log-transformed variables are sufficiently high and positive

The **Table 2** gives descriptive statistics of log-transformed of the 1st difference of variables. By JB statistics; as p-values for GSensex, GIIP, GIMPO is > 0.05, therefore, accept H_0 indicating normality of their distributions at α=5%. However, as the p-values for the remaining GSP500, GWPI, GEXR, GM3, GEXPO, GFER, and GGP is < 5%, therefore, reject H_0 .Thus, these series are not normally distributed. Six series are negatively skewed, whereas, others are positively skewed.

Table2: Descriptive Statistics of first difference of transformed variables

The correlation matrix of transformed first difference variables indicates that the correlation coefficient is positive and high. It is between GEXR & GM3 (0.8420), GIIP & GEXPO (0.671) and GIMPO & GEXPO (0.5936). The correlation coefficients are marginally positive for GSensex in pair with GSP500, GIIP, GFER, and GWPI. GSensex has a negative correlation with GEXR (–0.3296) and GM3 (–0.2581).

Five unit root tests for stationarity namely ADF, PP, KPSS, DFGLS and NG Perron are sequentially used. It was observed that LSensex, LSP500, LWPI, LIIP, LEXR, LM3, LIMPO, LEXPO LFER and LGP are all I (1). In order to test for cointegration which indicates long-term relationship of the times series; it is necessary that they should be stationary at the same level. Further the first difference of log-transformed series, i.e., GSensex, GSP500, GWPI, GIIP, GEXR, GM3, GIMPO, GEXPO, GFER and GGP are all I(0). The first step is to estimate VAR system for different lag length for these endogenous for VAR model.

Table 3 provides value of different information criteria - AIC, SIC and HQIC. According to **Guajarati (2010)**, none of these information criteria are statistically superior to the other. **Diebold (2001)** preferred SIC but the other researchers recommended AIC **(Caporal et al, 2004)**. Further, Akanke's and Hanna-Quinn criterion both confirm VAR (1); whereas, Schwartz selects a zero order as optimal. Therefore, in case of conflict AIC and HQ criterion has been preferred to make VAR (1) for the analysis.

Table 3: VAR Lag Order Selection Criteria

The cointegration of several variables indicates the existence of long-term relationship between trends of variables. By using Johansen cointegration test it is seen that model 4 shows that no cointegrating factor exist, as it is 4 by the trace and 2 by the max eigenvalue statistics. Similarly, model 2 also does not confirm any cointegrating factor as it is 5 by the trace and 3 by the max eigenvalue statistics. **Table 4** relates to the model selection process for identification of most the representative model.

Table 4 : Johansen Cointegration Ranks & Maximum value test for Model 3

Figure 1: Three cointegrating vectors by using Johansen (1988) test

Moving through **Table 4** for Model 3, row by row, First time, H_0 is not rejected at 5% when the numbers of cointegrating equations are 3. This happens as the $\boldsymbol{\lambda}_{trace}$ is 119.6162 < critical value = 125.6154 .This is also confirmed by the maximum eigen value test statistics $\boldsymbol{\lambda}_{max}$ =45.27229< critical value = 46.23142; when the number of cointegrating vectors is 3.

Thus, both trace test and maximum Eigenvalue test confirm the existence **of 3 cointegrating relationships** between Sensex and identified macroeconomic variables in the multivariate model.

Vector Error Correction Model [VECM]

Inferences drawn for the two hypotheses H_{0A}, H_{0B} are given below. Detailed conclusions are given sequentially against each sub-hypothesis.

H_{0A} : *There is a long-run and short-run relationship between identified macroeconomic variables and Sensex.*

H_{1A} : *There is neither a long-run nor short-run relationship between identified macroeconomic variables and Sensex.*

The null hypothesis is accepted as there are both long-run and short-run relationships between the Sensex and the nine identified macroeconomic variables, namely: S&P 500, inflation, IIP, exchange rate, M3, imports, exports, foreign exchange reserves and gold price. It is also confirmed by the Johansen cointegration test.

This finding implies that the Indian stock market is informationally inefficient. These variables may be used to predict stock movements. One reason for inefficiency could be the availability of limited information or lack of modernization of processes employed in information technology. The second reason is the absence of timely coordination to connect with the market for information relating to the fundamental economic activity.

H_{0B}*: There is a robust VAR model to explain the relationship between macroeconomic variables*
H_{1B}*: There is no robust VAR model to explain the relationship between macroeconomic variables.*

It is seen that there exists a VECM comprising of nine macroeconomic variables & Sensex which explains long-run and short-run relationships between them. The VECM is also useful for detecting Granger Causality when variables are cointegrated.

The VECM tests the hypothesis that past changes in the independent macroeconomic variables and error correction term is not a cause of current changes of the dependent variable. This implies to test the assumption that the coefficient of lagged macroeconomic variable and that of error correction terms are jointly zero.

Thus, the macroeconomic variables interact with each other to bring equilibrium in the system. The VECM also demonstrates casual relationships between the identified macroeconomic variables including Sensex. The Sensex is not a leading indicator and identified variables jointly bring back the system to long-term equilibrium.

Determination of number of Cointegrating Vectors

> ***H_{0C}****: There are no cointegrating relations.*
> ***H_{1C}****: There are cointegrating relations.*

In order to examine a long-run relationship, it is essential to determine number of cointegrating vectors by using **Johansen (1988)** test for cointegration, which is based on determination of the rank of Π. **Table 4 and Figure 1** indicates three cointegration relations.

Thus, the Johansen cointegrating trace and rank test confirms that there are three cointegrating equations at 5% level of significance indicating long-run equilibrium. Cointegration indicates long-run equilibrium relation. The stock price variability is related to macroeconomic variable and is identified by VECM. Further, the changes in the stock prices lag behind changes in the macroeconomic variables. Thus, the stock market index is not the leading economic indicator. This is inconsistent with the notion that stock market rationally signals economic activity.

Interpretation

There are three distinct cointegrating vectors in VECM showing long-run equilibrium. Different set of explanatory variables forms cointegrating equation (CE) **(Table 5).** These identified three cointegrating equations bring the system to the equilibrium independently.

Table 5: Vector Error Correction Model (VECM)

According to **Juselius** in multivariate co integration analysis, all variables are stochastic, and a shock to one variable is transmitted to all other variables until the system finds its new position of equilibrium. The first cointegrating vector is more useful **(Johansen and Juselius (1990)**

The three adjustment factors for the LSensex (-1) are associated with CEs:

α_{11}= - 0.116466; it brings back the system to equilibrium.

α_{12}= 0.171131; it makes to move away from the system.

α_{13}= -1.483533; it is fastest in bringing back the system to the equilibrium position.

As the t - values of α_{11} =-3.56806, α_{12} = 3.33266 and α_{13} = -3.99598 is greater than 1.96, these adjustment coefficients are significant. Thus LSensex with lag 1 efficiently takes in account disequilibrium so as to come back to the equilibrium steady state.

The first cointegrating vector's normalized [for β_{11}=1] values are:

$\beta' = [\beta_{11},\beta_{21},\beta_{31},\beta_{41},\beta_{51},\beta_{61},\beta_{71},\beta_{81},\beta_{91},\beta_{101}]$
= [1.00, 0.00, 0.00, 72.23, -23.84, 7.72, -53.93, 42.54, -6.85, and 10.91];

These are values which are the coefficients of LSensex(-1) (normalized one),LIIP(-1),LEXR(-1), LM3(-1) ,LIMPO(-1),LEXPO(-1),LFER(-1),LGP(-1).

Thus, the first regression equation is:

LSensex (-1) = -72.2334*LIIP (-1) +23.8364*LEXR (-1) -7.7241*LM3 (-1) +53.9323*LIMPO (-1) - 42.5421*LEXPO (-1) +6.8518*LFER (-1) + 10.9121*LGP (-1) + 73.7937.

Johansen (2005) has cautioned to infer about a coefficient in a cointegrating relation as it is based on the assumption of 'fixed' regressors. **Table 6** provides estimated long-run coefficients (β-values) and their statistical significance for the first cointegrating equation.

Table 6: Estimated long-run Coefficients (β- values) for Cointegrating Equation1

Hypothesis Relating to Macroeconomic Variables

H_{01}: *There is a positive relationship between stock price and IIP*

H_{11}: *There is a negative relationship between stock price and IIP*.

The increase of real economic activity represented by IIP is expected to have positive relation with the stock price, as the future cash flows generated by the manufacturing activity will have a positive influence on Sensex. **Fama (1990), Chen, Roll and Ross (1983)** also suggested a positive relationship. However, the results are contrary to the expected theory for the period of study; the relationship between IIP and Sensex is found negative. The decreased output has a positive effect on the Sensex. The reasons for opposite relations are multiple: usage of nonrepresentative IIP series (base year 1993-94) which uses outdated weights and data relating dormant companies. It could also be due to the speculative nature of the market. The other explanation for a negative relationship may be due to the inflationary pressure the input cost of manufacturing will increase, reducing margins thus lowering IIP. This will bring down Sensex as well. The negative sign also raises the question about reliability in usage of IIP. Most of the studies have used IIP as a proxy for GDP. IIP only relates to manufacturing process thus it cannot be used as a proxy for GDP. Further, IIP is determined on the old base year on which studies have been conducted till now. This may lead to wrong results. As the data for the IIP with the new base year for the period of study is not available, the analysis cannot be conducted with the new set of data series for IIP.

The relationship between IIP and Sensex may be further ascertained by refining the VECM model by segregating variables into endogenous and exogenous variables. Thus, to get a better picture of the relationship between IIP and Sensex; the new IIP series with modified data should be used, when it is completely available. The new IIP series with 2004-05 as base year, gives appropriate sectoral weights, revamps manufacturing components and captures the real industrial scenario.

H_{02}: *There is a positive relationship between exchange rate and stock price*
H_{12}: *There is a negative relationship between exchange rate and stock price.*

We have hypothesized a positive relationship between Sensex and exchange rate [LSensex (-1) and LEXR (-1)] , which is true. Sensex increases as the Indian Rupee depreciates against US$. **Mukherjee and Naka (1995) and Brown & Otsuki (1990)** confirmed a positive relationship between stock index and the exchange rate.

This indicates that when the exchange rate depreciates, the Indian exports become competitive in the international market and foreign exchange reserves increase, consequently, strengthening the Sensex. It is seen that the exchange rate has long-run negative relation with IIP. In the expanding Indian economy, increasing output results in finding new overseas market which tantamount to increased exports. This brings in more foreign exchange into the domestic market. This will result in appreciation of Rs with respect to $. Further, there is a marginal positive correlation between exchange rate and the Sensex (0.248). But due to strengthening of the $, domestic manufacturing with high import content will get affected and FIIs inflows will also slow down.

The RBI has a limited role in stabilizing the exchange rate as the problem relates to structural macroeconomic issues. Thus, timely stable exchange rate management policy and focusing on reforming policies to attract FIIs will bring overall growth and stability. Indian exporters should take advantage of the depreciating Rupee by finding out new markets and they should attempt to grow at a faster rate than the competing countries. This process will gradually strengthen the exchange rate.

***H_{03}* :** *There is a negative relationship between money supply and stock price*

***H_{13}*:** *There is a positive relationship between money supply and stock price.*

The null hypothesis H_{03} is accepted, that is, the decrease in the money supply increases stock price. It has been observed that the rate of inflation is positively related to money supply **(Fama 1982).** Thus, an increase in the money supply will enhance discount rate through inflationary expectation, which eventually decreases the stock price. The evidence presented by **Patra T & Poshakwale S (2006)** confirms this finding for Athens stock market, where, the indirect effect of the money supply on the stock prices through inflation was seen. Money supply may be related to the probabilistic increase of inflation which is negatively related to the share price. Further, decrease in the money supply reduces inflation which increases the demand of stocks. Opposite relation between Sensex and money supply were observed by **Ratanapakorn & Sharma (2007); Cheung & Lai (1999), Abdullah & Hayworth (1993), and Mukherjee and Naka (1995).**

Thus, increase in the money supply is not strengthening the Indian stock market due to poor Business Confidence Index and rising inflation. It is seen from the model that the money supply has negative relation with Sensex which confirms **'policy anticipation'.**
Hence, in order to strengthen Indian stock market business confidence needs to be improved by curbing inflation and improving the investment climate. Investor confidence increases by lowering inflation rate which will consequently attract long-run and short-run capital flow. This will enhance the demand of stocks resulting in an overall price increase.

***H_{04}* :** *There is a positive relation between imports and stock price.*

***H_{14}* :** *There is a negative relationship between imports and stock price.*

Positive relation between the imports and Sensex is observed. The correlation of Sensex with imports is high 0.899. The ratio of foreign exchange reserves to imports is within a reasonable

range. Thus, there are sufficient foreign exchange reserves for essential import of oil and fertilizer. Hence, despite an increase in imports it has no negative effect on the Sensex.
Further, as the import increases the trade deficit widens. This has negative effect on the exchange rate making the Rupee depreciate in comparison to the $. Indian exports become cheaper in the global market. Thus, for export-oriented and IT companies, the stock price will go up, which triggers the Sensex to rise. Thus, there exists positive relation between Sensex and imports.

An alternative explanation is an increase in the imports of Capital Goods (CG) will help in bringing in the latest technology. The manufacturing process gets improved making products of global quality. This will have a positive impact on Sensex movement after some time. Hence, imports are good for export-oriented companies or companies using Export Promotion Capital Goods (EPCG) scheme.
The increase in imports does not mean increased dependence on it. This implies that all imports are not harmful to the growth. Imports are beneficial for the domestic industry as it increases productivity and efficiency.
Therefore, the focus should on finding new export markets for ITeS and financial services sector and promote EPCG scheme so that despite an increase in the imports the economy grows.

H_{05} **:** *There is a positive relation between exports and stock price.*
H_{15} **:** *There exists a negative relation between exports and stock price.*

The relationship between exports and Sensex is observed to be opposite to the hypothesized positive relation. As imports go up, trade deficit widens which will have a negative impact on the exchange rate resulting in depreciation of the Rupee. The cost of imports for the domestic manufacturing goes up making margins low, which results in the decline of the stock price.

The exchange rate and exports have opposite signs. The exchange rate depreciation would stimulate exports and curtail imports while exchange rate appreciation will be detrimental to exports and encourages imports. When the Indian Rupee depreciates against the US dollar, Indian products become cheaper in the US. If the demand of these goods is elastic, the volume of the Indian exports should increase, causing higher $ inflows and, consequently, increasing Sensex returns. In case the Rupee appreciates against US dollar, export products becomes expensive for the buyer; hurting the exports and, thus, lowering Sensex. For the importer, if the Rupee becomes stronger then the imports will become cheaper. If the country is export dominant, the exchange rate appreciation will bring down competitiveness and affects domestic stock prices negatively . Whereas, if the country is import intensive, the exchange rate appreciation reduces costs and generates a positive impact on the domestic stock prices **Ratanapakorn & Sharma (2007).**

***H_{06}* :** *There is a positive relationship between stock price and foreign exchange reserve.*

***H_{16}*:** *There is a negative relationship between stock price and foreign exchange reserve.*

The relation between stock market and foreign exchange reserves is seen to be positive. Foreign exchange reserves are meant for essential imports, minimize risk and volatility in the stock market, repay foreign debts, maintain the exchange rate and develop investors' confidence. The increase in the foreign exchange reserves develops confidence in the domestic market for foreign investors. During 2011-12, the reserves touched an all-time high of $ 322.4 billion but declined to $ 304.8 billion by March 2011, due to the intervention of the RBI to control slide of the Rupee. The increase in the foreign exchange reserves gives stability and enhances investors' confidence. This encourages FIIs inflows, thus, strengthening Sensex.

Gradual liberalization and economic reforms enhanced the foreign exchange reserves. The policy conducive to maintain the inflow of FIIs, managing the stable exchange rate, and speeding the reforms process is essential for growth and value creation.

***H_{07}* :** *There is a positive relationship between stock price and the gold price.*

***H_{17}*:** *There is a negative relationship between stock price and the gold price.*

The relation between Sensex and gold price is found to be positive. There is a high positive correlation between gold price and Sensex (0.7744) for 1995-2009 and also a positive long-term relationship between both. Gold works as an effective hedge in volatile markets. Gold price over the period has gone up, and the Sensex has, mostly, increased gradually although there has been a decline in the Sensex return during the recessionary periods. But the correlation coefficient varied from minimum –0.9181 (2008) to maximum 0.9175 (2005). It is negative for 1995 to 1998, 2000 to 2001, 2006 and 2008. The correlation coefficient is positive in the remaining periods. In 2007, when the stock market touched the highest ever, the correlation between gold price and Sensex was insignificant (0.0289). This implies that investors would have not only gained from equity returns but would also have benefited by investing in gold. In 2008, the two assets were moving in the opposite directions indicating gold was protecting one's portfolio. Thus, for both periods, gold has acted as an effective hedge. It was also seen that the gold price has spiked over the period irrespective of Sensex movement on either side.

Gold ETFs was launched during the post sub-prime crisis in 2007; investors took refuge in the scheme. The decline in the foreign exchange reserve could be partially controlled by restricting imports of gold for investment purposes and focusing on imports of essentials which are mostly inelastic in nature.

***H_{08}* :** *There is a negative relation between inflation (WPI) and the stock price.*

***H_{18}*:** *There is a positive relationship between inflation (WPI) and the stock price.*

The second cointegrating equation indicates a positive relationship between money supply and inflation. It is observed that money supply has a negative relationship with Sensex; thus, inflation will also have a negative relation with Sensex which is consistent with the economic theory. The average inflation during 2011-12 remained high at 8.8%. **Fama & Schwert (1977), Geske and Roll (1983) and Chen, Roll and Ross (1986)** assumed negative relationship between equity returns and inflation. Increase in inflation leads to increase in the nominal risk-free rate which enhances the discount rate in the valuation model. The cash flows will not rise at the same pace as inflation, thus, reducing the stock price.

The 2nd explanation could be the high level of inflation creates uncertainty, increases the risk premium for holding equity which results in lowering the stock price. The RBI enhances policy interest rate as the inflation increases (it was increased 13 times in the past few years); this is to pressurize banks to move up the interest rate. The increase in the risk-free interest on the fixed deposits will be more attractive and safe in comparison to investment in the stocks due to the volatility of Sensex, and uncertainty in the US and Europe.

However, contrary to the negative relationship between Sensex and inflation, **Choudhry (2001)** found that Sensex and inflation have a positive relationship for high inflation economies, i.e., Argentina, Chile, Mexico and Venezuela.

Policy relating to confining inflation in a lower band may attract both FIIs and domestic investors to invest in the Indian stock market.

Error Correction for D (LSensex)

$Y_t = A_1 Y_{t-1} + C_1 + u_t$

$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Pi_{10x10} Y_{t-1} + C + u_t$

Where, $\Gamma_1 \Delta Y_{t-1}$ represents short-term relationship,

$\Pi_{10x10} Y_{t-1}$ Error Correction or represents long-term relationship.

The coefficient matrix of long-run $\Pi_{10x10} = \alpha\beta'$ gives error correction terms.

The error correction terms for D(LSensex) are given by 0.02815*D(LSensex(-1)) + 0.6500*D(LSP500(-1)) + 0.0462*D(LWPI(-1)) - 0.0006*D(LIIP(-1)) - 0.3971*D(LEXR(-1)) - 0.3774*D(LM3(-1)) - 0.0667*D(LIMPO(-1)) + 0.0521*D(LEXPO(-1)) - 0.3005*D(LFER(-1)) - 0.1549*D(LGP(-1))

$[\Pi_{11}, \Pi_{12}, \Pi_{13}, \Pi_{14}, \Pi_{15}, \Pi_{16}, \Pi_{17}, \Pi_{18}, \Pi_{19}, \Pi_{110}]$ are the coefficients of error correction terms for DLSensex

The estimated coefficient in the Error term is given by the **Table 7**

Table 7: Estimated Coefficients in the Error term for Dependent Variable

H_{09}*: *Π_{1i} *$=0$ for $i=1,2,\ldots.10$ (Regression coefficients of the error correction terms are zero)*

H_{19}*: *Π_{1i} *$\neq 0$ for all i.*

These regression coefficient terms in the ECM will give short-term Granger Causality. In case of the Sensex, it is seen that S&P 500 is the only significant variable. Thus, in the short-run S&P 500 Granger causes Sensex, but other variables are insignificant.

The hypothesis jointly tests that the coefficients of lagged variables and error correction terms in the VECM are zero. As these are significant therefore the lagged variables are significant in predicting the current value of dependent variables. Thus in the absence of the error correction term the model would have been misspecified.

Further, as Adj R^2 = 0.264, therefore, only 26% variation in growth in Sensex return can be explained by lag growth of independent variables. Further, as value of F=5.896 > $F_{9, 168, 5\%}$ =1.96, this implies rejection of the joint null hypothesis H_0: Π_{1i} =0 for $1 \leq i \leq 10$. Therefore, the regressors are significant, and the model is a good fit though it does not explain 74% variation in growth of Sensex. Thus, both long-run and short-run relationship for Sensex are represented and demonstrated by VECM. The current stock price adjusts to previous error correction. Significant past can predict the current stock price.

One of the limitations of the study is the usage of available old IIP data which may be overcome by usage of the new series of IIP with the base year 2004-05.This will provide a realistic reflection of the growth of the industrial sector as it overcomes problems relating to usage of outdated weights, fixed basket of products, and the inclusion of dormant companies. Analysis done using the new IIP will be realistic, reliable and robust. Further, unique economic conditions may be responsible for the existence of a difference between hypothesized and empirically observed relationships for a few macroeconomic variables and stock market prices. The VECM model may be further improved by using binding restrictions for testing weak Exogeneity of the identified variables. Usage of impulse response function and variance decomposition analysis for refined robust model could provide a better insight into relationships between identified macroeconomic variables.

5. Conclusion

This study analyzed both the long-run and short run relationship between the Sensex and nine macroeconomic variables during the post liberalization period from 1995 to December 2009. The cointegration analysis provides a suitable framework to test for equilibrium in the multivariate environment, and it also examines co-movements of variables. We have used **Johansen's (1991)** VECM to investigate whether a long-run relationship exists between Sensex and the nine macroeconomic variables. The general hypothesis about the existence of both long-run and short-run relationship between these identified variables was established. It was found that there are three distinct cointegrating vectors in VECM confirming long-run equilibrium.

It was observed that the relation between Sensex and exchange rate and foreign exchange reserves was positive. This indicates when the exchange rate depreciates, Indian exports become competitive in international market and foreign exchange reserves increase, consequently strengthening the Sensex. The relation between Sensex and Money supply is negative, implying that as the money supply increases, it enhances inflation resulting in a fall of Sensex. The gold price has a positive impact on Sensex. Surprisingly, the relationship between IIP and Sensex is negative. This may be due to usage of IIP series formulated on the base year 1993-94 which is outdated due to the wrong inclusion of products and nonexistent companies. Thus, the sign of elasticity coefficients of macroeconomic variables for long-run are consistent with the economic theory. It was also found that around 26% change in the growth of Sensex is jointly explained by the lag growth of independent variables. Further, the regressors are also jointly significant implying that the VECM is a good fit.

To sum up, the study has developed a robust VECM model explaining the existence of both the long-run and short-run relationship, and casualty between the macroeconomic variables and Sensex, which could provide better insight and help in policy formulation.

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Tables

Table1: Time Series Transformation

Variables	Transformed Variables	Growth Rate	Significance
SENSEX	LogSENSEX=lSENSEX	gSENSEX =d(lSENSEX,1)=log[$SENSEX_t$/$SENSEX_{t-1}$]	**Return on SENSEX**
SP500	LogSP500=lSP500	g SP500= d(lSP500,1) =log[$SP500_t$/ $SP500_{t-1}$]	**Return on SP500**
WPI	LogWPI=lWPI	gWPI=d(lWPI,1) =log[WPI_t/WPI_{t-1}]	**Growth in inflation rate**
IIP	LogIIP=lIIP	gIIP = d(lIIPI,1) = log[IIP_t/IIP_{t-1}]	**Rate of growth of industrial production**
EXR	LogEXR=lEXR	gEXR= d(lEXRI,1) = log[EXR_t/EXR_{t-1}]	**Change in exchange rate**
M3	LogM3=LM3	gM3= d(lM3,1) = log[$M3_t$/ $M3_{t-1}$]	**Rate of growth of money supply**
IMPO	Log IMPO =lIMPO	gIMPO= d(lIMPO,1) = log[$IMPO_t$/ $IMPO_{t-1}$]	**Growth rate of imports**
EXPO	Log EXPO =lEXPO	gEXPO=d(lEXPO,1) = log[$EXPO_t$/ $EXPO_{t-1}$]	**Growth rate of exports**
FER	Log FER =lFER	gFER= d(lFER,1)=log[FER_t/ FER_{t-1}]	**Change in foreign exchange reserve**
GP	Log GP =lGP	gGP= d(lGP,1)=log[GP_t/ GP_{t-1}]	**Change in gold price**

Table2: Descriptive Statistics of first difference of transformed variables

	GSENSEX	GSP500	GWPI	GIIP	GEXR	GM3	GIMPO	GEXPO	GFER	GGP
Mean	0.008794	0.004413	0.004249	0.007034	0.002215	0.015345	0.015954	0.013169	0.0166	0.008348
Median	0.014439	0.010618	0.003173	0.005632	0.000753	0.013049	0.00711	0.012015	0.014243	0.004714
Maximum	0.248851	0.092324	0.026896	0.146312	0.065657	0.082882	0.311237	0.280508	0.132715	0.409009
Minimum	-0.27299	-0.18564	-0.02029	-0.13283	-0.06642	-0.0434	-0.29689	-0.36301	-0.06209	-0.16628
Std. Dev.	0.07928	0.046422	0.006563	0.051515	0.015538	0.01851	0.112146	0.118268	0.028661	0.04985
Skewness	-0.35864	-0.93612	0.198627	-0.25798	0.522454	0.526678	0.142464	-0.33966	0.557108	2.816345
Kurtosis	3.380762	4.59354	5.377852	3.515094	8.327098	5.191202	2.791883	3.750639	5.004793	25.92778
Jarque-Bera	4.918511	45.08281	43.34777	3.964335	219.7957	44.08565	0.928542	7.644377	39.23583	4157.353
Probability	0.085499	0	0	0.13777	0	0	0.628593	0.02188	0	0
Observations	179	179	179	179	179	179	179	179	179	179

Table 3: VAR Lag Order Selection Criteria

Endogenous variables: GSensexGSP500 GWPI GLIIP GEXR GM3 GIMPO					
Exogenous variables: C					
Included observations: 171					
Lag	Log	LR	AIC	SC	HQ
0	3404.117	NA	-39.69728	-	-39.62273
1	3593.550	354.4938	-	-38.72232	-39.92326*
2	3659.618	115.9094	-40.34641	-36.48823	-38.78093
3	3750.916	149.4924	-40.24463	-34.54921	-37.93367
4	3829.618	119.6645	-39.99553	-32.46289	-36.93911
* indicates lag order selected by the criterion					
LR: sequential modified LR test statistic (each test at 5% level)					
AIC: Akaike information criterion			HQ: Hannan-Quinn information criterion		
SC: Schwarz information criterion					

Table 4 : Johansen Cointegration Ranks & Maximum value test for Model 3

Unrestricted Cointegration Rank Test (Trace)				
Series: LSensex LSP500 LWPI LIIP LEXR LM3 LIMPO LEXPO LFER				
Hypothesized no. of CE(s)	Eigenvalue	Trace Statistics	Critical Value 5%	Prob.**
None *	0.376913	317.3546	239.2354	0.0000
At most 1 *	0.289238	233.1484	197.3709	0.0002
At most 2 *	0.256513	172.3760	159.5297	0.0082
At most 3	0.224571	119.6162	125.6154	0.1096
At most 4	0.120257	74.34387	95.75366	0.5678
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized no. of CE(s)	Eigen value	Max-Eigen Statistic	Critical Value 5%	Prob.**
None *	0.376913	84.20626	64.50472	0.0003
At most 1 *	0.289238	60.77238	58.43354	0.0289
At most 2 *	0.256513	52.75983	52.36261	0.0455
At most 3	0.224571	45.27229	46.23142	0.0631
At most 4	0.120257	22.80624	40.07757	0.8849
**MacKinnon-Haug-Michelis (1999) p-				

Table 5: Vector Error Correction Model (VECM)

Vector Error Correction Estimates(Partial Version)			
Standard errors in ( ) & t-statistics in [ ]			
Cointegrating Eq:	CointEq1	CointEq2	CointEq3
LSensex(-1)	1.000000	0.000000	0.000000
LSP500(-1)	0.000000	1.000000	0.000000
LWPI(-1)	0.000000	0.000000	1.000000
LIIP(-1)	72.23342	35.67637	-1.570752
	(16.7650)	(9.30675)	(0.25732)
	[4.30858]	[3.83339]	[-6.10423]
LEXR(-1)	-23.83641	-16.30852	0.203479
	(21.6890)	(12.0402)	(0.33290)
	[-1.09901]	[-1.35450]	[0.61123]
LM3(-1)	7.724147	5.142673	-0.083746
	(13.2566)	(7.35913)	(0.20347)
	[0.58266]	[0.69882]	[-0.41158]
LIMPO(-1)	-53.93230	-30.13927	0.693811
	(6.70186)	(3.72040)	(0.10287)
	[-8.04736]	[-8.10109]	[6.74487]
LEXPO(-1)	42.54212	24.49179	-0.527732
	(8.63568)	(4.79392)	(0.13255)
	[4.92632]	[5.10893]	[-3.98148]
LFER(-1)	-6.851808	-3.561256	0.030775
	(5.91495)	(3.28356)	(0.09079)
	[-1.15839]	[-1.08457]	[0.33898]
LGP(-1)	-10.91205	-5.053467	0.122169
	(4.94256)	(2.74376)	(0.07586)
	[-2.20777]	[-1.84181]	[1.61041]
C	-73.79369	-45.54333	-0.059113

Error Correction Terms

Error Correction	**D(LSensex)**
CointEq1	-0.116466
	(0.03264)
	[-3.56806]
CointEq2	0.171131
	(0.05135)
	[3.33266]
CointEq3	-1.483533
	(0.37126)
	[-3.99598]
D(LSensex(-1))	0.028157
	(0.07251)
	[0.38831]
D(LSP500(-1))	0.650077
	(0.11474)
	[5.66552]
D(LWPI(-1))	0.046218
	(0.94719)
	[0.04879]
D(LIIP(-1))	-0.000666
	(0.16595)
	[-0.00401]
D(LEXR(-1))	-0.397112
	(0.72106)
	[-0.55074]
D(LM3(-1))	-0.377398
	(0.57114)
	[-0.66079]
D(LIMPO(-1))	-0.066742
	(0.06711)
	[-0.99447]
D(LEXPO(-1))	0.052096
	(0.07558)
	[0.68930]
D(LFER(-1))	-0.300459
	(0.20328)
	[-1.47803]
D(LGP(-1))	-0.154907
	(0.14753)
	[-1.05000]
C	0.018753
	(0.00979)
	[1.91574]
R-squared	0.318467
Adj. R-squared	0.264443
F-statistic	5.894925

VAR MODEL

D(LSensex) = - 0.1165*(LSensex(-1) + 72.2334*LIIP(-1) - 23.8364*LEXR(-1) + 7.724*LM3(-1) - 53.9323*LIMPO(-1) + 42.5421*LEXPO(-1) - 6.8518*LFER(-1) - 10.9121*LGP(-1) - 73.7937) + 0.1711*(LSP500(-1) + 35.6764*LIIP(-1) - 16.3085*LEXR(-1) + 5.1426*LM3(-1) - 30.1393*LIMPO(-1) + 24.4918*LEXPO(-1) - 3.56126*LFER(-1) - 5.0535*LGP(-1) - 45.5433) - 1.4835*(LWPI(-1) - 1.5708*LIIP(-1) + 0.20348*LEXR(-1) - 0.0837*LM3(-1) + 0.6938*LIMPO(-1) - 0.5277*LEXPO(-1) + 0.0308*LFER(-1) + 0.1222*LGP(-1) - 0.0591) + 0.0282*D(LSensex(-1)) + 0.6501*D(LSP500(-1)) + 0.0462*D(LWPI(-1)) - 0.0007*D(LIIP(-1)) - 0.3971*D(LEXR(-1)) - 0.3774*D(LM3(-1)) - 0.0667*D(LIMPO(-1)) + 0.0521*D(LEXPO(-1)) - 0.3005*D(LFER(-1)) - 0.1549*D(LGP(-1)) + 0.0189

Where

D(LX)=LX-L(X(-1))

D(LX(-1))= LX(-1)- LX(-2)

Table 6: Estimated long-run Coefficients (β- values) for Cointegrating Equation1

	Variables	H_0	H_1	|t-value|	$Tab_{167,0.02}$	Inference
1	LIIP(-1)	$\beta_{41}=0$	$\beta_{41}\neq 0$	4.30858	1.96	Reject **H_0** LIIP(-1) is significant
2	LEXR(-1)*	$\beta_{51}=0$	$\beta_{51}\neq 0$	1.09901	1.96	Accept **H_0** LEXR(-1) is insignificant
3	LM3(-1) *	$\beta_{61}=0$	$\beta_{61}\neq 0$	0.58266	1.96	Accept **H_0** LM3(-1) is insignificant
4	LIMPO(-1)	$\beta_{71}=0$	$\beta_{71}\neq 0$	8.04736	1.96	Reject **H_0** LIMPO(-1)is significant
5	LEXPO(-1)	$\beta_{81}=0$	$\beta_{81}\neq 0$	4.92632	1.96	Reject **H_0** LEXPO(-1)is significant
6	LFER(-1) *	$\beta_{91}=0$	$\beta_{91}\neq 0$	1.15839	1.96	Accept **H_0**LFER(-1) is insignificant
7	LGP(-1)	$\beta_{101}=0$	$\beta_{101}\neq 0$	2.20777	1.96	Reject **H_0**LGP(-1)is significant

*It is seen in the next section that LEXR (-1), LM3 (-1) and LFER (-1) are weakly exogenous

Table 7: Estimated Coefficients in the Error term for Dependent Variable

	Estimated Coefficients in the Error term for Dependent Variable D(LSensex)			
	Independent Variable	Π'	**Coefficient**	**t- value**
1	D(LSensex(-1)	Π_{11}	0.028157	[0.38831]
2	D(LSP500(-1)	Π_{12}	0.650077	[5.66552]*
3	D(LWPI(-1)	Π_{13}	0.046218	[0.04879
4	(LIIP(-1)	Π_{14}	-0.000666	[-0.00401]
5	D(LEXR(-1))	Π_{15}	-0.397112	[-0.55074}
6	D(LM3(-1)	Π_{16}	-0.377398	[-0.66079]
7	D(LIMPO(-1)	Π_{17}	-0.066742	[-0.99447]
8	D(LEXPO(-1)	Π_{18}	0.052096	[0.68930]
9	D(LFER(-1)	Π_{19}	-0.300459	[-1.47803]
10	D(LGP(-1)	Π_{110}	-0.154907	[-1.05000]
11	C		0.018753	[1.91574]

Figure

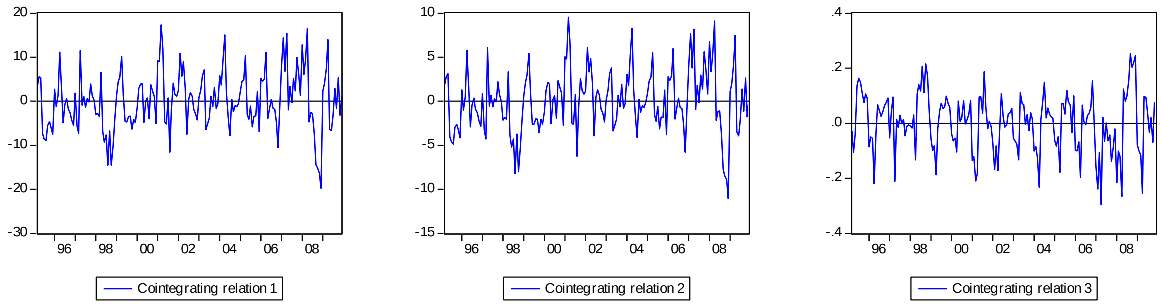

Figure 1: Three cointegrating vectors by using Johansen (1988) test